

Section 9 Asset Class – Roadway Structures:

The Roadway Structures asset class consists of the transportation structures that are associated with the street network and includes:

- ✓ Areaway Street Walls
- ✓ Bridges
- ✓ Bridge Hydrant Vaults
- ✓ Retaining Walls

All roadway structures are maintained by the Roadway Structures group in the Capital projects and Roadway Structures Division.

Areaway Street Walls:

Areaways are spaces that exist under sidewalks and are situated between the street and the adjacent building. Although there are a variety of reasons why areaways exist around Seattle, the most common case is the reconstruction and raising of street grades in the Pioneer Square area following the Great Seattle Fire of 1889. Street walls were built, and the street area was filled. These are older structures and were built from the 1890s through the 1940s. SDOT owns and maintains most of the areaway street walls in the city of Seattle, as well as a few of the sidewalks that are adjacent to the areaway street wall and are supported by the street wall. In most cases, the areaway itself is considered private, as it is used by the adjacent property owner under a street use permit.

The areaway street wall provides a necessary and important support to the street fill and utilities.

Current Inventory and Anticipated Annual Growth:

The inventory of areaway street walls has been maintained in the Structures database since 1994. The last physical inventory effort took place in the 1980s.

There are 205 known areaway street walls in Seattle, or approximately 144,620 square feet. Records of the original construction of street walls are often missing, and the location of a previously unknown street wall will occasionally be discovered in the process of new development or renovation of buildings in the downtown area. No new street walls are planned.

The estimated replacement value of areaway street walls is \$155 million in current dollars.

Condition Ratings:

SDOT conducts inspections of both areaways (a regulated asset), and areaway street walls and, although a regular inspection cycle has not been established, Roadway Structures believes a 3-5 year inspection cycle of areaway street walls is desirable to maintain these street walls in good condition. If critical defects are noted on the areaways during an inspection, the inspectors contact Street Use who then contacts the adjacent property owner and requests that repairs be made.



Areaway and Areaway Street Wall

Sidewalks are an integral structural component of the areaway, and, although maintenance responsibility is decided on a case-by-case basis between SDOT and the adjacent property owner, the condition rating of the areaway street wall includes consideration of the condition of the sidewalk as well as the areaway street wall.

**Areaway Street Wall Condition Rating
(Estimated)**

Good	Fair	Poor	% Condition TBD
3%	68%	11%	21%

The areaway street walls that are rated in good condition are the six (6) that have been restored. All remaining areaway street walls require rehabilitation or replacement.

The areaway street wall inventory and condition rating are updated after any periodic inspection is completed.

Roadway Structures does not have funding for a regular maintenance program for the areaway street walls. Emergency response situations that are addressed may require midyear budget adjustments or new appropriations.

Funding for areaway work, either fill or restoration, is allocated on a case-by-case basis through the city's CIP process.

Unmet Funding Needs:

The street walls are of varying construction ranging from brick to reinforced concrete. None of the street walls meet current design standards. Less than 5% of the areaway street walls have been rebuilt/replaced. Current funding does not allow rehabilitation/replacement within the 75-year useful life.

Roadway Structures estimates that there are 35 areaways/areaway street walls in poor condition that could either be filled or restored. Approximately \$5.4 million would be required to fill seventeen (17) of the areaways, and an additional \$22.5 million (est) is necessary to restore/rehabilitate the other eighteen (18) areaways.

Bridges:



Bridges are elevated structures that facilitate efficient and direct travel routes between points in Seattle's street network that are disrupted by physical features or topography. Absent a bridge at such locations, travel routes would be inefficient and circuitous, if possible at all.

There are multiple categories of bridges:

- ✓ Movable Vehicular Bridges
- ✓ Non-movable Vehicular Bridges
- ✓ Pedestrian Bridges



University Bridge

Non-movable vehicular bridges are further classified for maintenance purposes based on the structural materials used in the bridge:

- ✓ Steel
- ✓ Reinforced Concrete
- ✓ Timber
- ✓ Composite

SDOT has sole ownership and maintenance responsibility for 96 bridges and shares partial ownership and maintenance responsibilities for others. For bridges that are partially owned by SDOT, SDOT is responsible for maintenance which is funded through the General Fund; full replacement is funded by the partner. SDOT also performs reimbursable maintenance work on

bridges belonging to other city and state departments, and performs inspections on SDOT bridges as well as privately owned bridges within the ROW. Occasionally, SDOT inspects and maintains other city department bridges on an as needed basis.

Current Inventory and Anticipated Annual Growth:

The inventory of bridges has been maintained in the Structures database since 1980. The inventory of bridges includes all bridges where SDOT performs maintenance work: SDOT sole/partial ownership, as well as privately owned bridges in the ROW and bridges where SDOT crews perform reimbursable work.

The number of bridges in sole and partial SDOT ownership is:

Category of Bridge	Number in Sole Ownership	Number in Partial Ownership
Movable Vehicular Bridge	4	
Non-movable Vehicular Bridge	70	37
Pedestrian Bridge	12	

The bridge inventory is updated after the routine annual bridge inspection program is completed.

SDOT builds an additional 6,408 square feet of new bridge deck annually. This figure represents an average taken over the last fifteen (15) years.

The estimated replacement value of SDOT-owned bridges is \$1.5 billion..

Condition Ratings:

SDOT conducts an annual bridge inspection program. Components of each bridge are inspected on a regular cycle:

- ✓ Routine Inspection – every 1-2 years
- ✓ Underwater Inspection – every 5 years
- ✓ Fracture Critical – every 2 years
- ✓ Special Features – every 2 years

An inspection schedule is established for each bridge, and a bridge may undergo more than one inspection in any given year if condition dictates. Inspections are conducted according to federal

regulations. Condition information collected during the inspection is recorded in the Structures database.

The condition rating of bridges for which SDOT has sole/partial responsibility is:

**Bridge Condition Rating
July 2007**

% in Good Condition	% in Fair Condition	% in Poor Condition
51	10	39

A bridge rated in poor condition does not imply that the bridge is unsafe for vehicular traffic. A bridge condition rating considers many factors, such as traffic volumes. Bridges rated in poor condition qualify for replacement funding, and replacement funding may be pursued, for example, when current traffic demand has grown to a level that exceeds the traffic volume for which the bridge was designed when it was originally constructed. If the condition of a bridge deteriorates below a level considered safe for the load carrying capacity, the allowable vehicle weight is restricted on that bridge. SDOT has eight (8) bridges where weight restrictions have been posted and two (2) bridges that have been closed to vehicular traffic.

Useful Life and Life Cycle Costs:

The useful life of bridges depends on the structural materials.

**Useful Life of Bridges
In Years**

Structural Material	Condition of Bridge		
	Good	Fair	Poor
Steel and Concrete	55-75	20-54	<20
Timber and Composite	40-50	10-39	<10

The cost of a new bridge varies considerably and is dependent on many factors, including structural materials, span, expected traffic volume, and topography. Construction costs average \$500 per square foot of bridge deck area.

Routine maintenance costs range from \$150,000 to \$1.5 million over the life of a bridge. For a movable bridge, operational costs range from \$25-37.5 million over the life of the bridge.

When a bridge is replaced, decommission costs range from \$3,375 to \$2,137,500.

Since bridges are so long-lived, the replacement cost for a bridge will escalate significantly by the end of its useful life. A steel bridge that costs \$50 million to build today may cost as much as \$460 million to replace in 75 years.

Maintenance Approach:

Bridges are repaired on a priority basis up to the level of available funding according to the same maintenance response criteria described in the stairways section of this report. These work slips represent routine maintenance activities and do not include major rehabilitation or replacement of major bridge components, such as expansion joints.

Roadway Structures responds to reports of damaged railings within eight (8) hours of notification.

Roadway Structures must operate movable bridges in accordance with Coast Guard regulations and, therefore, must maintain the bridges at a level that will ensure compliance, as well as meet expectations of commuter traffic:

- ✓ Draw bridge must open within ten (10) minutes of a vessel request 99% of the time
- ✓ Immediate response to safety issues or a bridge stuck in the “open” position
- ✓ All lanes open during commuter hours

Prior to 2007, funding did not allow establishment of a maintenance program that ensured a level of maintenance that would prevent further deterioration of the bridges. Since a bridge is so long-lived, a maintenance program requires replacement of major components of the bridge on a recurring cycle, rather than replacement of the entire structure:

- ✓ Paint steel bridges every fifteen (15) years
- ✓ Replace bridge deck every 25 years
- ✓ Replace expansion joints every 25 years
- ✓ Replace railing after 50 years

Roadway Structures has established an annual program for painting bridges that provides for roll-over of funds from one budget year to another to allow the accrual of funds necessary to address this high-cost replacement need. A list of these bridges is available in Appendix D.

BTG has provided the ability to reduce the backlog of bridge maintenance requests.

Current Performance Measure:

Roadway Structures has established the following performance measure for bridges:

Performance Measure	2009 Actual	2010 Goal
Bridge repair requests completed	399	270-320

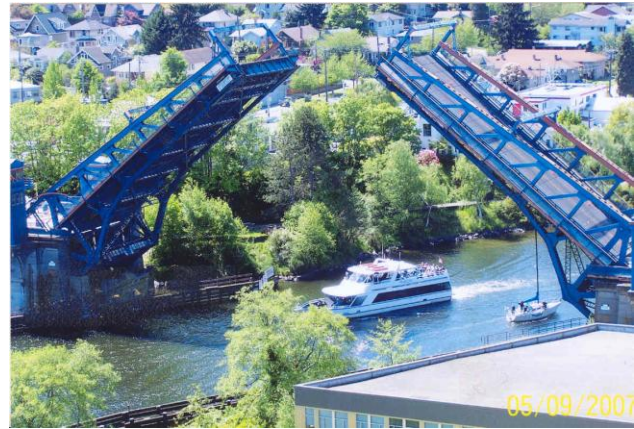
Roadway Structures is currently maintaining 61% of the bridges in fair or better condition.

Funding Requirements:

Routine Maintenance:

The 2010 Roadway Structures funding is \$ 2.2million for all structures maintenance, of which bridges are the major part. and \$2.5 million for bridge operations.

At the end of 2008, Roadway Structures carried a backlog of 1,271 work slips. The division can complete an average of 535 annually, as compared to approximately 600 new slips written each year. Work slips vary in cost, but the current average is more than \$5,000. The Roadway Structures would need more than \$7 million to eliminate all backlogged work, and a budget of \$3 million annually to stay current on all slips generated. The average number of new work slips generated each year is an estimate as of 2008. As a bridge ages, there is a point when a bridge will hit the deterioration curve at which point the amount of required routine maintenance will begin to rise significantly. Where rehabilitation is completed, the number of work slips will decrease. Both of these factors will affect the rate of increase/decrease of the backlog, and, if maintenance is deferred, the number of new work slips will increase accordingly.



Fremont Bridge

Major Rehabilitation and Replacement of Major Bridge Components:

The funding for bridge maintenance that has been described above is for routine maintenance only. It does not cover major rehabilitation work that is necessary to preserve the bridges. Funding for major rehabilitation is provided through CIP projects and annual programs. In the 2010-2015 CIP, there is funding allocated for these bridges : Airport Way over Argo, 15th Avenue NE at NE 105th Street, East Duwamish Waterway, Jose Rizal, East Marginal Way at Horton Street, and NE 45th Street Viaduct

Unmet Funding Needs:

Bridge engineers believe that if maintenance is deferred longer than ten (10) years, the rate of deterioration will accelerate and result in an even larger backlog. To enable the elimination of the backlog within ten (10) years, an additional \$275,000 would be required each year for routine maintenance.

The unmet need for major rehabilitation and replacement is classified in three (3) ways:

- ✓ Annual Programs, which includes such maintenance as bridge painting and replacement of railing
- ✓ CIP rehabilitation projects
- ✓ CIP bridge replacement projects

A complete list of the unfunded major rehabilitation and replacement projects is listed in Appendix D.

In summary, the unmet funding need for major rehabilitation and replacement is:

Unfunded Bridge Major Rehabilitation & Replacement

Project Type	Total Cost (Millions)
Annual Programs	\$ 131.4
CIP Rehabilitation Projects	\$ 152.0
CIP Bridge Replacement Projects	\$ 387.6

Bridge Hydrant Vaults:

Bridge hydrant vaults are utility vaults located on bridges that house the piping and electrical systems which provide water to hydrants used by the Seattle Fire Department (SFD). Hydrant vaults are built to meet SFD guidelines for hydrant placement.

Current Inventory and Anticipated Annual Growth:

There are thirteen (13) bridges with hydrant vaults which are located on the Klickitat Bridge, the WS Swing Bridge and Highrise, and the 1st and 4th Avenue bridges. The inventory of bridge hydrant vaults is tracked through bridge utility maps that show where they are located underground.

Anticipated annual growth has not been determined for bridge hydrant vaults.

Estimated replacement value is not available.

Condition Ratings, Useful Life and Life Cycle Costs, and Maintenance Approach:

Condition is not currently recorded for bridge hydrant vaults, however, preventive maintenance is performed monthly to ensure that they remain in service 98% of the time on a 24/7 basis.

Additional information was not pursued for this reporting period.

Current Performance Measures:

Performance measures have not been developed for bridge hydrant vaults.

Funding Requirements and Unmet Funding Needs:

This information was not pursued for this reporting period.

Retaining Walls:

A retaining wall is a roadway structure that supports streets when there is a near-vertical grade separation as the result of fill or cut of a slope. A retaining wall prevents earth matter and/or water from collapsing onto Seattle's transportation infrastructure by establishing level areas on hillsides when roadways are constructed. Seawalls are a category of retaining walls that are built along the shore and are partially or fully submerged.

Retaining wall construction varies by type and materials used: cantilevered reinforced concrete, concrete gravity, slab & rail, rockery, timber pile & lagging, mechanically stabilized wall, steel "H" pile & RC, steel "H" pile & reinforced concrete lagging.

The Alaskan Way Seawall is the city's longest retaining wall, measuring over 7,000 feet long, and protects the central city waterfront along Elliott Bay.



Retaining Wall

Current Inventory and Anticipated Annual Growth:

The inventory of retaining walls has been maintained in the Structures database since 1994. SDOT owns and maintains 582 retaining walls in the city of Seattle.

On average, 1-3 new retaining walls are built each year, or approximately 1,125-3,375 square feet. Retaining walls are often built by developers, and ownership and maintenance responsibility is turned over to SDOT. The number of new retaining walls built per year may increase dramatically if there is a high incidence of landslides in any given year, as was the case in 1996-1997 when ten (10) new retaining walls were built.

The estimated replacement value of retaining walls is \$1.8 billion, including the Alaskan Way Seawall.

Condition Ratings:

Retaining wall condition is assessed through periodic inspection. Complete inspection of retaining walls started in the late 1980s and has been conducted on the average of once every ten (10) years given current funding levels. Roadway Structures engineers believe a preferred approach is to conduct condition assessment every five (5) years.

Retaining Wall Condition Rating 2008 Structures annual report

% in Good Condition	% in Fair Condition	% in Poor Condition
43	37	20

SDOT conducts regular inspections, including underwater inspections, and monitoring of the Alaskan Way seawall. The seawall is considered in poor condition, and SDOT is developing a project to replace the central waterfront section of the seawall. In recent years, SDOT has performed some

major repair work via capital projects on portions of the seawall, including earthquake damage repair following the 2001 Nisqually Earthquake. The seawall has effectively reached the end of its useful life, however, and replacement is the preferred alternative.

Condition information is recorded in the Structures system.

Useful Life and Life Cycle Costs:

A newly installed retaining wall has an expected useful life of 75 years and costs approximately \$700 per square foot or \$6,000 per linear foot to install. Routine maintenance costs currently average about \$0.50 per square foot over the life of a retaining wall.

Retaining walls that are rated in fair condition have a life expectancy of 15-39 years. The rehabilitation cost for a retaining wall in fair condition ranges from \$50,000-\$300,000.

A retaining wall that has degraded to poor condition has a remaining useful life of less than fifteen (15) years. Disposal costs for a retaining wall range from \$10,000 to \$1 million.

Maintenance Approach:

Retaining walls are repaired on a priority basis up to the level of available funding according to the same maintenance response criteria described in the stairways section. This funding allows Roadway Structures to inspect and maintain the retaining walls in a functional state, but does not allow establishment of a maintenance program that will ensure repair of defects that would prevent further deterioration of the retaining wall, nor to rehabilitate or replace aging retaining walls.

Rehabilitation and/or replacement of retaining walls is conducted through specific capital projects on a case-by-case basis.

Roadway Structures maintains the retaining walls in a manner that ensures that there is no more than one (1) lane closure per year due to a failure in the retaining walls.

Current Performance Measures:

Performance measures have not been developed for retaining walls.

Funding Requirements:

Roadway Structures has a modest budget of approximately \$200,000 for routine maintenance of retaining walls. The annual funding for routine maintenance is a static figure and additional funding to cover the annual increase in square footage of new retaining walls is needed.

If allocated equally across the inventory of retaining walls, maintenance funding averages approximately \$300 per year per retaining wall.

Unmet Funding Needs:

Unmet funding needs in the near term are focused on replacement of retaining walls in poor condition starting with the top 26 needing replacement (see Appendix D) for a total in excess of \$7,649,000 as well as the replacement of the Alaskan Way seawall.